1 Introduction

AQIM Handbook

Contents

Purpose

The AQIM Handbook provides an information source for:

- I implementing AQIM activities,
- Training employees about risk analysis and management, and
- Analyzing information enabling managers to make risk-based decisions

Scope

The AQIM Handbook covers background information about the Government Performance Results Act (GPRA) and its influence to integrate risk analysis and risk management into PPQ's Agriculture Quarantine Inspection (AQI) program. With that introduction, the Handbook then provides necessary information about statistics, risk analysis, and a sampling process to provide the foundation for implementing AQIM. Next, the Handbook provides guidelines and instruction for setting up designated locations for AQIM. The remainder of the Handbook is divided into pathway sections.

Given that AQIM is a different way of conducting business, this Handbook is an attempt to provide officers and managers with background and guidance to implement AQIM activities. As processes improve and are developed, the Handbook will expand in its scope. Along with specific documents written to establish local procedures, such as a standard operating procedure, this Handbook will serve as the information tool for implementing AQIM activities and for training individuals about risk analysis and risk management.

The Handbook is divided into 15 major sections:

- Introduction
- Start-Up
- Air—Passenger Baggage
- Air—Cargo
- Maritime—Cargo
- Mail Facility
- Northern Border—Vehicles
- Northern Border—Truck Cargo
- Southern Border—Vehicles
- Southern Border—Truck Cargo
- Predeparture

- Rail
- Glossary
- Appendixes
- Index
- Blank Tabs (for local use)

The Introduction section provides basic information about the Handbook and information that supports AQIM activities. The information includes background; the GPRA; strategic plans, performance plans, reports, and budgets; agriculture quarantine inspection monitoring; basic statistics and their importance to AQIM activities; the fundamentals of risk analysis; and the sampling process established for AQIM activities.

The Start-Up section provides a list of activities for setting up a designated location that is implementing AQIM, the roles and responsibilities of individuals involved, and a checklist to help designated locations implement AQIM.

The pathway sections begin with Air—Passenger Baggage and end with Rail. The sections are tabbed with color for easier access from the other sections of this Handbook. Each pathway section has a set of national guidelines developed for a specific pathway covering the following topics:

- Introduction and sampling guidelines
- Data collection and maintenance guidelines
- Data analysis guidelines

The Glossary defines specialized words, abbreviations and acronyms, and other difficult terms used related to risk analysis, risk management, and AQIM.

The Appendixes list information, such as governing Acts, key contacts, duties, examples of forms, and samples of standard operating procedures.

The blank tabs allow work locations to add information about AQIM that is specific to that location, for example, a copy of the local standard operating procedure, information lists, and contacts.

Audience

The AQIM Handbook is used primarily by CBP Agriculture Specialists, PPQ employees (including officers, managers, technicians, identifiers) involved in AQIM activities. The users would include those who are responsible for:

- Determining a random sampling scheme
- Completing data worksheets
- Entering information into the Agriculture Quarantine Activity System (AQAS)
- Interpreting information in AQAS
- Documenting statistical information
- Monitoring AQIM implementation
- Conducting risk management

Secondary users of the information in this Handbook would include specialists of PPQ's Permits and Risk Assessments and cooperators from Veterinary Services and other Federal agencies.

Related Documents

The Government Performance Results Act (GPRA) of 1993 is the basis for implementing AQIM. This Act is introduced in this Handbook beginning on **page-1-5**.

Another related document that describes a new way of doing business is titled, "Safeguarding American Plant Resources" dated July 1, 1999. This document describes the new systems needed to deliver plant protection programs. AQIM activities support a safeguarding system founded on risk-based pathway studies and performance measurement that allow maximum effectiveness of operations.

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AQIM Handbook

Introduction

The Government Performance and Results Act

Background

The Government Performance and Results Act (GPRA), which was passed by Congress in 1993, is a law that requires all government programs to be managed based on results achieved. This process includes setting specific program outcome targets, measuring progress towards those outcomes, and analyzing and using the results to make program improvements. The law connects this focus on program outcomes to the budget development process by requiring the President's budget, starting in FY 99, to include the following for each program activity:

- A long-term (5 year) strategic plan that includes a comprehensive mission statement and general outcome oriented goal statements;
- Annual performance plans, including annual measurable goals and indicators of goal achievement; and,
- Annual performance reports which show whether measurable goals have been achieved.

Managing for results requires a different conceptual or philosophical framework. Use Table 1-1 to view the difference between our old framework and that of GPRA.

TABLE 1-1: One Way Of Viewing The Difference Between The Old Framework And that Of GPRA

In the old framework for managing programs, the focus was on:	When managing for results, the focus is on:
Inputs	Outcomes
Process	Results
Activities	Strategic Objectives
Compliance	Performance
Management Control	Management Improvement
Retrospective Data Analysis	On-going Monitoring
Reporting Data	Using Data

The remainder of this section of the Introduction contains excerpts from the Comptroller General of the United States dated June 1996, effectively implementing the GPRA (GAO/GGD-96-118).

Federal Management Reform

Over the past several years, Congress has taken steps to fundamentally change the way Federal Agencies go about their work. Congress took these steps in response to management problems so common among Federal Agencies that they demanded government-wide solutions. In addition, two contemporary forces converged to spur Congressional action:

- Year-in and year-out budget deficits that had to be brought down, and
- A public now demanding not only that Federal Agencies do their jobs more effectively, but that they do so with fewer people and at lower cost.

This change was, and remains, an enormous challenge. For one thing, many of the largest Federal Agencies find themselves encumbered with structures and processes rooted in the past, aimed at the demands of earlier times, and designed before modern information and communications technology came into being. These Agencies are poorly positioned to meet the demands of the 1990's. Moreover, many of these Agencies find themselves without a clear understanding of who they are or where they are headed. Over the years, as new social or economic problems emerged, Congress assigned many Agencies new and unanticipated program responsibilities. These additions may have made sense when they were made, but their cumulative effect has been to create a government in which many Agencies cannot say just what business they are in.

In some cases, Agencies' legislative mandates have grown so muddled that Congress, the executive branch, and other Agency stakeholders and customers cannot agree on program goals, worthwhile strategies, or appropriate measures of success.

Traditionally, Federal Agencies have used the amount of money directed toward their programs, or the level of staff deployed, or even the number of tasks completed as some of the measures of their performance. But at a time when the value of many Federal programs is undergoing intense public scrutiny, an Agency that reports only these measures has not answered the defining question of whether these programs have produced real results.

Today's environment is ***results-oriented***. Congress, the executive branch, and the public are beginning to hold Agencies accountable less for inputs and outputs than for outcomes, by which is meant the results of government programs as measured by the differences they

make, for example, in the economy or program participants' lives. The difference between outcomes and outputs is the key to understanding government performance in a results-oriented environment.

Legislative Requirements

Congress' determination to make Agencies accountable for their performance lay at the heart of two landmark reforms of the 1990's:

- The Chief Financial Officers (CFO) Act of 1990, and
- The Government Performance and Results Act of 1993 (GPRA).

With these two laws, Congress imposed on Federal Agencies a new and more businesslike framework for management and accountability. In addition, the GPRA created requirements for Agencies to generate the information that decision makers in Congress and the executive branch need when considering measures to improve government performance and reduce costs.

The CFO Act was designed to remedy decades of serious neglect operating and reporting financial management. While the CFO Act established the foundation for improving management and financial accountability among the Agencies, GPRA is aimed more directly at improving their program performance. The GPRA requires that Agencies consult with Congress and other stakeholders to clearly define their missions. It requires that they establish long-term strategic goals, as well as annual goals that are linked to them. They must then measure their performance against the goals they have set and report publicly on how well they are doing.

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Introduction

Strategic Plans, Performance Plans, Reports, and Budgets

Background

The experiences of leading organizations suggest that the successful implementation of the Government Performance and Results Act (GPRA) may be as difficult as it is important. For example, obtaining agreement among often competing stakeholders is never easy, particularly in an environment where available resources are declining. In addition, measuring the Federal contribution to outcomes that require the coordinated effort of numerous public and private entities--such as improvements in education, employment, or health--can require sophisticated and costly program evaluations. Three key steps are contained within the guidelines of the GPRA that redefine the methods by which strategic plans, performance plans, reports, and budgets are developed and conducted within the Federal sector. These three key steps are:

- Define Mission and Desired Outcomes
- Measure Performance
- Use Performance Information

Step 1—Define Mission/Desired Outcomes

The GPRA requires that federal agencies, no later than September 30, 1997, develop **strategic plans** covering a period of at least 5 years and submit them to Congress and the Office of Management and Budget (OMB). If done well, continuous strategic planning provides the basis for everything the organization does each day.

Strategic plans are intended to be the starting point for each agency's performance measurement efforts. Each plan must include a comprehensive **mission statement** based on the agency's statutory requirements, a set of outcome-related strategic goals, and a description of how the agency intends to achieve these goals.

The **mission statement** brings the agency into focus. It explains why the agency exists, tells what it does, and describes how it does it.

The **strategic goals** that follow are an outgrowth of the clearly stated mission. The strategic goals explain the purposes of the agency's programs and the results they are intended to achieve.

For strategic planning to have this sort of impact, three practices appear to be critical. Organizations must do the following:

- Practice 1—Involve their stakeholders;
- Practice 2—Assess their internal and external environments; and
- Practice 3—Align their activities, core processes, and resources to support mission-related outcomes.

Practice 1—Involve Stakeholders

Successful organizations base their strategic planning, to a large extent, on the interests and expectations of their stakeholders. These organizations recognize that stakeholders will have a lot to say in determining whether their programs succeed or fail.

Among the stakeholders of Federal Agencies are Congress and the administration, State and local governments, third-party service providers, interest groups, Agency employees, and the American public.

Involving customers is important as well. An Agency's customers are the individuals or organizations that are served by its programs. This is not to say that contact between a Federal Agency and its customers is always direct. Many Federally mandated or Federally funded services are dispensed through third parties, such as State agencies, banks, or medical insurance providers. In such cases, Federal Agencies face the particularly challenging task of balancing the needs of customers, service providers, and other stakeholders, who at times may have differing or even competing goals.

Practice 2—Assess The Environment

Successful organizations monitor their internal and external environments continuously and systematically. Organizations that do this have shown an ability to anticipate future challenges and to make adjustments so that potential problems do not become crises. By building environmental assessment into the strategic planning process, they are able to stay focused on their long-term goals even as they make changes in the way they intend to achieve them.

Assessing the **external environment** is particularly important, in part because so many external forces that fall beyond an organization's influence can powerfully affect its chances for success. For organizations both public and private, external forces can include newly emerging economic, social, and technological trends and new statutory, regulatory, and judicial requirements.

An organization's **internal forces** include its culture, its management practices, and its business processes. Today, Federal Agencies find that monitoring these internal forces is especially important, given the

effects of funding reductions and reorganizations. The tools available to organizations assessing the internal environment include program evaluations, employee surveys, independent audits, and reviews of business processes.

Practice 3—Align Activities, Core Processes, and Resources

An organization's activities, core processes, and resources must be aligned to support its mission and help it achieve its goals. Such organizations start by assessing the extent to which their programs and activities contribute to meeting their mission and desired outcomes. As organizations became more results-oriented, they often find it necessary to fundamentally alter activities and programs so that they can more effectively and efficiently produce the services to meet customers' needs and stakeholders' interests.

As Agencies align their activities to support mission-related goals, they should match funding with their anticipated results. Under a series of initiatives called Connecting Resources to Results, OMB is seeking to adopt a greater focus on Agencies' goals and performance in making funding decisions.

Leading organizations strive to ensure that their core processes efficiently and effectively support mission-related outcomes. This sort of integrated approach may include tying individual performance management, career development programs, and pay and promotion standards to organizational mission, vision, and culture.

Step 2—Measure Performance

After defining their missions and desired outcomes, the second key step that successful, results-oriented organizations take is to measure their performance. **Measuring performance** allows these organizations to track the progress they are making toward their goals and gives managers crucial information on which to base their organizational and managerial decisions.

The GPRA incorporates performance measurement as one of its most important features. Under the Act, agencies are required to develop annual performance plans that use performance measurement to reinforce the connection between the long-term strategic goals outlined in their strategic plans and the day-to-day activities of their managers and staff. The **annual performance plans** are to include the following:

- Performance goals for an Agency's program activities as listed in the budget,
- A summary of the necessary resources to conduct these activities,

- The performance indicators that will be used to measure performance, and
- A discussion of how the performance information will be verified.

Practices 4 and 5 are designed to ensure that performance measures are an integral part of Agency activities.

Practice 4—Produce a Set Of Performance Measures

The experiences are that at least four characteristics are common to successful hierarchies of performance measures. That is, a set of performance measures must be produced at each organizational level that:

- **Demonstrate Results—**Performance measures should tell each organizational level how well it is achieving its goals.
- **Limited To The Vital Few—**The number of measures for each goal at a given organizational level should be limited to the vital few. Those vital few measures should cover the key performance dimensions that will enable an organization to assess accomplishments, make decisions, realign processes, and assign accountability.
- **Respond To Multiple Priorities—**Government agencies often face a variety of interests whose competing demands continually force policy makers and managers to balance quality, cost, customer satisfaction, stakeholder concerns, and other factors. Performance measurement systems must take these competing interests into account and create incentives for managers to strike the difficult balance among competing demands.
- **Link To Responsible Programs—**Performance measures should be linked directly to the offices that have responsibility for making programs work. A clear connection between performance measures and program offices helps to both reinforce accountability and ensure that, in their day-to-day activities, managers keep in mind the outcomes their organization is striving to achieve.

Practice 5—Collect Sufficiently Complete, Accurate, and Consistent Data

As successful organizations develop their performance measures, they pay special attention to data collection. As the experiences of these organizations demonstrated, managers striving to reach organizational goals must have systems in place to provide them with needed information.

Step 3—Use Performance Information

After establishing an organizational mission and goals and building a performance measurement system, the third key step in building successful results-oriented organizations is to put performance information to work. Managers should use **performance information** to:

- Continuously improve organizational processes,
- Identify performance gaps, and
- Set improvement goals.

Organizations that progressed the farthest to results-oriented management did not stop after strategic planning and performance measurement. They applied their acquired knowledge and information to:

- Identify gaps in performance,
- Report on the performance, and
- Improve performance to better support their missions.

Practices 6 through 12 give structure to identifying and responding to performance information.

Practice 6—Identify Performance Gaps

Performance information can have real value only if they are used to identify the gap between an organization's actual performance level and the performance level it has identified as its goal. Once the performance gaps are identified for different program areas, managers can determine where to target their resources to accomplish the mission. When managers are forced to reduce their resources, the same analysis can help them target reductions to keep to a minimum the threat to the mission.

By analyzing the gap between where they are and where they need to be to achieve desired outcomes, management can:

- Target those processes that are in most need of improvement,
- Set realistic improvement goals, and
- Select an appropriate technique to improve processes.

Practice 7—Report Performance Information

Annual performance reports document the progress made toward achieving the goals established in annual performance plans. The reports link levels of performance to the budget expenditures, which is consistent with the GAPER's requirements that annual performance plans be tied to budget requests.

Practice 8—Use Performance Information To Support The Mission

Federal Agencies are feeling the pressure to demonstrate that they are putting the taxpayers' money to sound use. They are expected to demonstrate improved performance even as they cut costs--two simultaneous demands that are driving the trend toward results-oriented government.

As they focus on the outcomes they hope to achieve, federal managers increasingly are finding that the traditional ways they measured their success--and thus the traditional ways they did business and provided services--are no longer appropriate or practical.

Practice 9—Devolve Decision Making With Accountability

Leading organizations create a set of mission-related processes and systems within which to operate, along with giving their managers extensive authority to pursue organizational goals while using those processes and systems. Allowing managers to bring their judgment to bear in meeting their responsibilities, rather than having them merely comply with overly rigid rules and standards, can help them make the most of their talents and lead to more effective and efficient operations.

Practice 10—Create Incentives

Across government, the best incentive Congress can apply to foster results-oriented management is to use information about performance measurement to make decisions about policy, program, and resource allocation, and to provide agencies with the authority and flexibility to achieve results.

Successful organizations define their missions clearly and communicate them to their employees--particularly to their managers--so that they understand their contribution. At both the organizational and managerial levels, accountability requires results-oriented goals and appropriate performance measures through which to gauge progress.

Practice 11—Build Expertise

To make the most of results-oriented management, staff at all levels of an organization must be skilled in strategic planning, performance measurement, and the use of performance information in decision making. Training has proven to be an important tool for Agencies that want to change their cultures.

Results-oriented managers view training as an investment rather than an expense. And as experts in human resource management at leading private and public organizations have pointed out,

organizational learning must be continuous in order to meet changing customer needs, keep skills up to date, and develop new personal and organizational competencies.

Practice 12—Integrate Management Reforms

Within a given Federal Agency, the management reforms now under way may come from various sources. Some of these reforms may be self-initiated, others may have been mandated by legislation, still others may be the result of administration initiatives such as the National Performance Review. All of these reform activities need to be integrated, as the CFO Council urged in May 1995:

> "Existing planning, budgeting, program evaluation and fiscal accountability processes should be integrated with the GPRA requirements to ensure consistency and reduce duplication of effort. In addition, other management improvement efforts, such as implementation of the CFO Act, and FMFIA (Federal Managers' Financial Integrity Act), customer service initiatives, reengineering, and Total Quality Management, etc., should be incorporated into the GPRA framework to capitalize on the synergy and availability of key information and to improve responsiveness to customers and other stakeholders".

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Introduction

Agriculture Quarantine Inspection Monitoring (AQIM)

Introduction

This section of the Introduction gives you the what's and the why's of AQIM.

What Is AQIM?

AQIM is a group of activities initiated to help PPQ become a results-oriented organization. That is, an organization that uses information about the performance and the pathway risk of the Agricultural Quarantine Inspection (AQI) program to make decisions.

The PPQ Executive Team initiated AQIM for two basic reasons:

- To provide information for risk-based decision-making; and
- To meet the requirements of the Government Performance and Results Act (GPRA) of 1993. (Refer to page-1-5 for an explanation of the GPRA.)

What Is Risk Based Decision Making?

PPQ is accountable for reducing the pest threat to U.S. agriculture in a way that does not unduly restrict commerce. To accomplish this, PPQ is moving to better methods for determining not only what to inspect, but how to inspect it. Many of those methods use **risk analysis**.

Risk analysis in business and government provides the framework for organizing and presenting information. This framework helps employees select and justify their actions. For unimpeded trade and movement of commodities in today's world, PPQ must show that we inspect and treat imports and people based on the widely accepted science of risk analysis.

Traditionally, PPQ based work on the quantity of pest interceptions and quarantine material intercepted (QMI). This seemed logical. We filled our inspection tables with QMI, we found pests, and we tallied them to justify a good job performance. We did not, however, consider the seriousness of the threat posed by the pest. In other words, we based our effort on quantity, not the quality of the risk.

When time is spent on low risk activities, then work on high risk pathways suffers. Each work location must assess the risk of a particular pathway and change that assessment as trade and travel changes.

We decrease the entry potential of our worst pests when we track pathways, predict risk, and reassign our work. This process of tracking, predicting risk, and reassigning work based on those predictions is **risk-based decision making**. Therefore, the information produced from AQIM provides us with what we need to assess the risk of entry of exotic pests and diseases.

How Does AQIM Produce Information?

Information is needed for risk management and the GPRA. To produce the necessary information, AQIM uses a sampling process to estimate the amount and kind of quarantine materials and pests approaching a work location via various known pathways of pest entry. Relative pathway risks can be measured by plugging in estimated numbers of actionable pests and information about pest destination into risk assessment models. We are using information from AQIM to measure the gap between the **estimated** amount of quarantine materials or pests approaching a location and the **actual** amount being intercepted by PPQ at that location.

AQIM data is collected and entered at designated locations into a computer database called Agriculture Quarantine Activity System (AQAS) . This software allows each location to do simple analyses of the data. The information from locations is also sent to PPQ's Quarantine Policy, Analysis & Support Staff for submission to the national database and further analysis.

Monitoring results can be used at various levels within PPQ. Work locations can use the results to verify the risk of various entry pathways and to shift resources to activities that are most effective in managing risks. State and regional offices can use the results to assess the relative risks of various entry pathways and locations. At a national level, the information can be used to assess risk, redesign regulations, and justify budget requests.

Who Is Responsible?

A national monitoring team has input in coordinating AQIM via the national coordinator in Headquarters. Information is collected by inspectors at designated locations. Basic analysis and use of the monitoring data can be accomplished by PPQ managers and

employees at work locations to assist in decision making processes. A list of key contacts is in **Appendix B** of this Handbook for your reference.

Developing an appropiate sampling process is an important part of this effort. Designated locations must give considerable thought to a sampling process to ensure the gathering of valid and useful information about pathway risk and program performance. The national monitoring team can offer help in setting up a sampling process that is practical and sustainable at designated locations.

Who Is Involved?

Designated locations around the country and in Puerto Rico are collecting data. In order for AQIM to be fully operational, most ports of entry locations will need to become involved in some way. Each designated location collecting information selects an AQIM coordinator and assistant (refer to "Roles and Responsibilities" on **page 2-5** for more information). An infrastructure at the regional and national levels is also set up to coordinate the program implementation (refer to **Appendix B** for information on key contacts for AQIM).

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Introduction

Statistics and AQIM

Introduction

Statistics deal with the collection, analysis, and interpretation of information. The AQIM process uses proven statistical techniques to collect monitoring information about various pathways and the commodities entering through them into United States. The information is then used to explain and to explore the characteristics of the various pathways to assist in managing the risk they present to U.S. agriculture.

The information collected as part of AQIM will have very practical uses that will impact the work of port employees. Statistics will allow PPQ to use the AQIM information to respond to such practical questions as:

1. How much cargo approaching the work location is carrying actionable pests? What is the level of infestation of the pests in the cargo?
2. What poses the greater risk of spreading citrus canker? Is it maritime imports from South America or air passenger transport of home-grown fruit?
3. How effective is a work location in managing the pest and quarantine material threats that are identified through AQIM?

The use of valid, statistical techniques allows PPQ to establish the facts of the situation, and allows officers and managers to make risk-based decisions.

The following section provides additional information to better understand the role of statistics in monitoring and PPQ operations.

The Why of Statistics

Statistics allow for the objective analysis of information. The principles behind statistics help guide us to use the best methods for gathering information about a population without giving bias to the information.

Historically, PPQ has used selective criteria choosing inspectional units that are the most likely to transport something of agricultural interest. Inspectional units that don't fit the criteria have less of a chance of being selected--that isn't random sampling. When selecting random samples, selective criteria cannot be used.

In AQIM, ports of entry randomly select pathway entrants to create a picture representative of the entire population. For example, the population might be all air passengers arriving at the international terminal of an airport. The random sampling unit would consist of 10 custom declarations (and associated passengers' baggage) per day for a year, or of 3,650 passengers for the year. The sample would be selected randomly, such that every passenger had the same chance of selection. The randomness could be achieved in many different ways. One example might be that the random sampling units are selected at preselected random times of the day.

The data could be further refined to reflect which of those units in the population pose a threat and which do not. Why do we do this? So that we can draw inferences and make decisions about the population in an objective, scientific way. **Statistical inference** is drawing conclusions about the larger population from smaller, randomly sampled portions. From these sampled portions, we can construct generalizations about the population with varying levels of confidence.

Random Selection as a Key Step

In order to draw accurate conclusions about the larger population from a smaller subset or sample of the population, it is important that the subset be as similar to the larger group as possible. This means that each unit in the subset must be randomly chosen from the larger population. Consequently, each unit of the larger population must have the same chance of being randomly selected.

Because sampling units are chosen randomly where all units have the same chance of being selected, we can measure the error involved in the information. This measure of error will allow us to judge how good our information is and how much confidence we have in the overall monitoring process.

What Are The Implications for AQIM?

There are several implications of using a random sampling process for AQIM.

1. Monitoring is not the same as using selective criteria to determine a random sampling unit. (See the section about AQIM Sampling Process beginning on page-1-39 for additional information.)
2. It is imperative that selected sampling units are truly random. This eliminates the possibility of human choice or preference in the selection.

3. Biasing the information to reflect high levels of pest and quarantine material interceptions, will mislead the interpretation. In some instances, giving higher levels than what really exists will cause a work location to appear extremely inefficient because time is spent on low risk activities, rather than on high risk pathways. Additionally, showing a no or low risk rate can result in high risk pathways being interpreted as low risk causing inappropriate staffing to occur.
4. Selected random sampling units must be thoroughly inspected to be sure if pests or quarantine materials are present. The goal is to have a clear snapshot of what is approaching a work location.
5. The goal of AQIM is not in the number of pest interceptions and DIM's collected, but in the decisions based on risk and analysis that can be drawn from the monitoring.

Statistical Concepts

There are several ways of analyzing the monitoring information that has been collected. This section addresses the types and benefits of analysis that are available.

Following are definitions of some basic terms used when analyzing monitoring information:

Confidence Interval—A level of belief that the true value of the population was captured. For AQIM, the numbers of samples taken at each work location were designed to ensure that by detecting the presence of certain pests and quarantine materials during the monitoring, PPQ could be 95 percent sure that it would happen again.

Data—Raw information that provides values for any characteristic of a larger population. For AQIM, these would be all the entries on the data collection form (i.e., flight number, origin, contaminant codes, etc.).

Mean—This term is also referred to as the average. It is computed by adding all the values for a characteristic and dividing by the number of observations. For example, the mean of passengers going through an airport in a day would be the total number of passengers in one year divided by 365 days.

Probability—The statistical prediction of the likelihood of possible outcomes.

Sample—The part (or a subset) of a population that has been selected for monitoring.

Simple Random Sampling—A selection process where each member of the population must have a known probability (greater than 0) of being sampled.

Variable—Any characteristic on which the elements of a sample differ from each other (i.e., height versus weight, cargo destinations versus type).

Data is the information that is collected from a **random sampling unit** (or smaller subsets) that accurately depicts characteristics (measured **variables**) of the larger population. Gathering data for AQIM is **simple random sampling** where we collect information regarding specific variables. This is done so we can predict the likelihood of an event occurring such as a pest or quarantine material interception. The number of inspections conducted at a work location is established so that there will be a **95 percent confidence interval**.

Types of Analysis and Use

There are several types of analysis that can be done with the AQIM data. The analysis can range from the simple to the complex. Explained here are some of the more useful methods available for use at your work location. More detailed analysis questions are located under the following pathway sections: Air—Passenger Baggage, Air—Cargo, Maritime—Cargo, Mail, Northern Border—Vehicles, Northern Border—Truck Cargo, Southern Border—Vehicles, Southern Border—Truck Cargo.

The simplest analysis is just to look at **a listing of the data**. Listings can answer questions such as what, what kind, and how many. Figure 1-1 is an excerpt from a listing of the data gathered for passenger vehicles at a work location along the Southern border. Looking at the data could tell how many inspections were made on what dates, and the types of items being found.

REC.#	WORK UNIT	DATE	TIME DESTIN	ITEM
1413	Laredo, TX	01/01/97	1110 TX	Orange
1414	Laredo, TX	01/01/97	1300 TX	.
1415	Laredo, TX	01/01/97	1253 TX	.
1416	Laredo, TX	01/01/97	2010 TX	.
1417	Laredo, TX	01/01/97	2330 TX	.
1418	Laredo, TX	01/02/97	2130 TX	.
1419	Laredo, TX	01/02/97	2015 TX	.
1420	Laredo, TX	01/02/97	1540 TX	Apple
1421	Laredo, TX	01/04/97	0845 TX	.

FIGURE 1-1: An Example of a Listing Data

Since there are many variables in the data files for each work location, you have the option to **select** one of those records with specific variables that you are interested in looking at. Refer to Figure 1-2 for an example of records containing quarantine material.

REC.#	WORK UNIT	DATE	TIME DESTIN	ITEM
1421	Laredo, TX	01/04/97	0845 TX	Orange
1428	Laredo, TX	01/08/97	1927 TX	Apple
1432	Laredo, TX	01/10/97	1849 TX	Sugarcane
1453	Laredo, TX	01/14/97	1840 TX	Hay
1466	Laredo, TX	01/17/97	1840 TX	Pear
1486	Laredo, TX	01/05/97	0813 TX	Avocado, w/seed
1590	Laredo, TX	01/20/97	1005 TX	Orange
1614	Laredo, TX	01/24/97	0854 TX	Apple
1631	Laredo, TX	01/25/97	0900 TX	Eggs

FIGURE 1-2: Printout of Records Having Specific Information

Frequencies answer the question, “To what degree do unique values exist in a variable?” Looking at the frequency of a certain variable will show summary data about the variable. For example, running a frequency on the date variable will give the number of inspections that were done on each date as well as the total number of inspections.

Figure 1-3 shows the frequency of items intercepted. You get a list of the different types of items intercepted and how many there were in the monitoring samples.

ITEM	Freq	Percent	Cum.
APPLE	3	30.0%	30.0%
AVOCADO, W/ SEED	1	10.0%	40.0%
EGGS	1	10.0%	50.0%
HAY	1	10.0%	60.0%
ORANGE	2	20.0%	80.0%
PEAR	1	10.0%	90.0%
SUGARCANE	1	10.0%	100.0%
Total	10	100.0%	

FIGURE 1-3: Printout of Frequencies of Items Intercepted

Frequencies, as well as the raw data, can also be displayed graphically using **pie** and **bar charts**. Refer to Figure 1-4

.

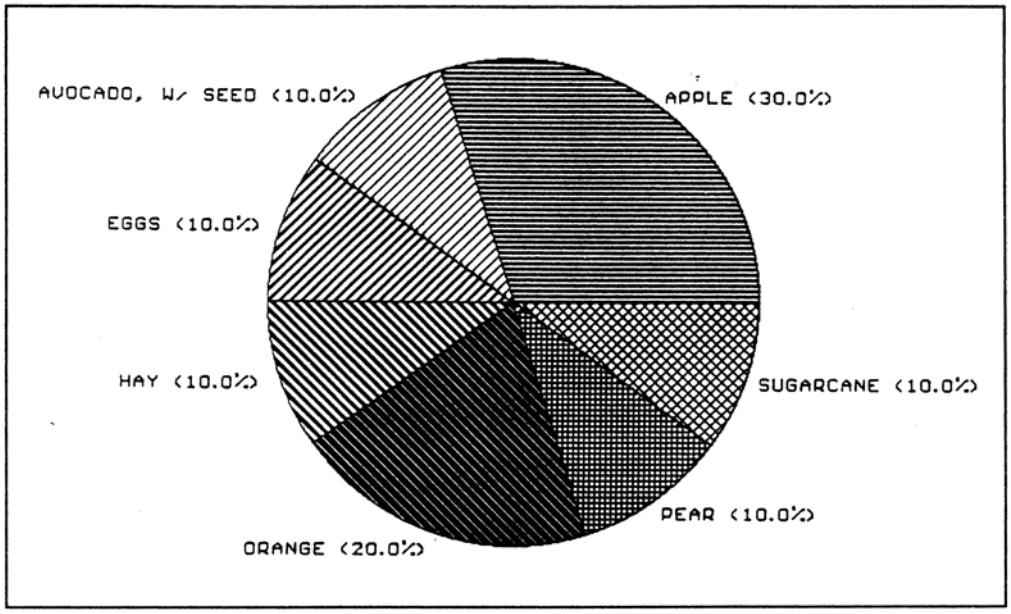

FIGURE 1-4: Example of Frequencies Displayed Using Pie Chart

Means or averages give an overview of the general tendency of a variable. The average number of passengers on a declaration might be of interest for your work location. This could be calculated by dividing the total number of passengers in the data file by the number of declarations (or samples). We can calculate the 'error' in this estimate and express it in the form of a **confidence interval**. Remember that the confidence interval gives an indication of how accurate the estimate is.

Proportions show the relative frequency of an event. For AQIM, we may be interested in the proportion or percentage of passengers with a QMI. We could calculate this by dividing the total number of QMI's by the number of passengers. We can also compute a confidence interval around proportions.

Next Steps

These are all statistics that are necessary to initially conduct and understand AQIM. Using statistics and risk management principles will become more critical as PPQ progresses toward complying with the GPRA and evaluating results-based performance.

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AQIM Handbook

Introduction

Fundamentals of Risk Analysis

Basics About Risk

Agriculture is a business filled with numerous risks. Pests, diseases, weather, and market fluctuations continually impact the potential earnings of producers. These elements of risk and the reaction of producers and consumers to that risk, result in agricultural policy setting and government programs.

USDA has several programs by which it enhances overall U.S. agricultural markets; ranging from economic forecasting to genetic research. APHIS, PPQ helps protect the natural agricultural resource base of the United States by minimizing the entry potential of risk elements, which would increase the risk agents (i.e., pests and diseases). These efforts are designed to help give producers the best possible standing in international markets.

In the past, APHIS, PPQ has responded to risk issues on a historical knowledge basis. Through observation and experience, officers made judgements and decisions about the potential threat posed by various commodities entering the United States. These decisions must now be supported by empirical information.

Risk analysis processes give PPQ a basis for responding to the new mandates required by the international trade agreements: General Agreement on Tariffs and Trade (GATT) and North American Free Trade Agreement (NAFTA). GATT and NAFTA require transparency of risk-based decisions impacting agricultural products in U.S. markets. Therefore, PPQ must do business differently than in the past because of these new mandates. For information and criteria about risk management, refer to the **APHIS Trade Risk Analysis Position** paper and the **GATT Agreement on the Application of Sanitary and Phytosanitary Measures** located in **Appendix C** of this Handbook.

The basic function of PPQ is to manage exotic pest and plant disease risk. To accomplish this work, decisions must be based upon the risk that various commodities pose to U.S. agriculture. At the heart of risk-based decision-making is the need for good information. Because PPQ does not have perfect knowledge about the absolute risk of a particular pest, disease, or commodity; decisions must be made with clear understanding, knowledge, and an element of uncertainty.

Risk Analysis Process

Risk analysis is the process, tools, and methodologies by which organizations estimate the likelihood and potential consequences of an adverse event. International trade agreements require these processes be consistent, systematic, and transparent. Therefore, the organizational objective is that risk-based decision-making should be pervasive throughout all levels of PPQ and APHIS.

A risk analysis process places risk analysis activities within an organizational context. The process provides an internal structure and roles and responsibilities, which define and respond to risk-based policy issues. A risk analysis process comprises risk assessment, risk management, and risk communication. Figure 1-5 chronicles the difference between risk assessment, risk management, and risk communication.

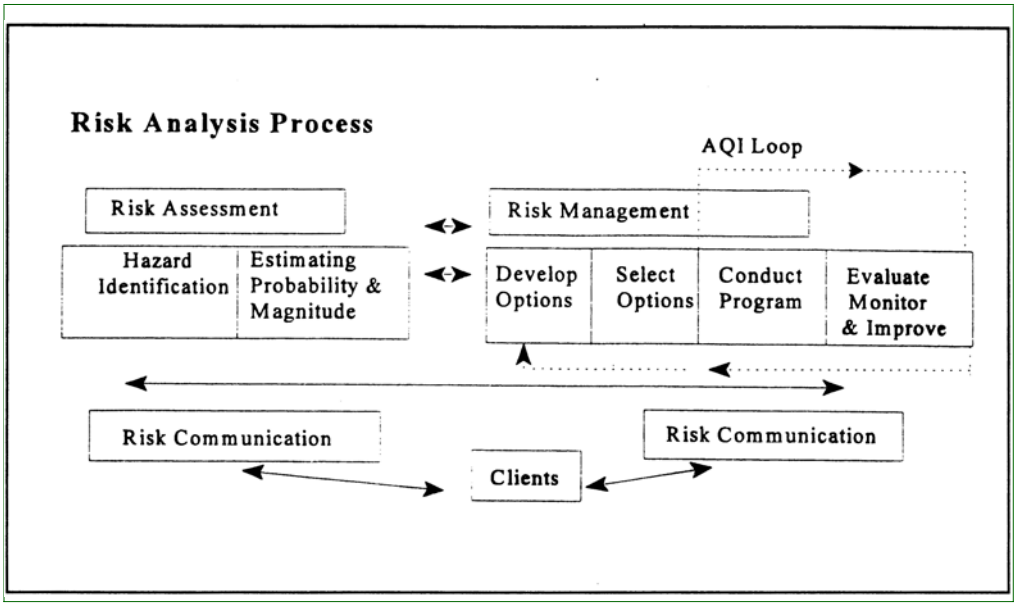

FIGURE 1-5: A Model of a Risk Analysis Process

The risk assessment (or analysis) portion of the model pays attention to estimating the probability and magnitude of the risk. Analysis ends with developing and selecting options. AQIM plays a major role in evaluating, monitoring, and improving options or mitigation programs. As risk analysis processes are used, it is essential to communicate with clients to ensure programmatic goals are met, and to ensure the results improve or to re-tool the process.

Field work occurs primarily at the implementation levels of risk management. PPQ officers are responsible for implementing risk management programs; monitoring and evaluating those programs;

and adjusting and improving activities to ensure that risk is being managed at the best possible level. Risk analysis is a systematic way of achieving risk-based decisions.

The major barrier to risk analysis is reliable data. Data errors may come from improper sampling procedures, errors in record-keeping and data entry or faulty analysis. In addition, risk analysis must take into account aggregate risks. For example, fruit that has citrus canker poses one level of threat while fruit that is contaminated with medfly poses another. However, if infested with citrus canker and medfly, the risk rate is more intense.

From a risk management viewpoint, agency leaders must actively respond to:

- What can be done to prevent, reduce, or eliminate the risk?
- What are the best options?
- Why?

There are multiple uses of risk analysis: problem definition, risk prediction, risk avoidance measures, mitigation strategies, management programs, and standards for protecting agriculture. From risk analyses, work locations can evaluate ongoing risk reduction activities; determine management and policy priorities; and identify and rank research and data collection needs.

The following model on pest risk assessment (analysis) gives context to risk analysis processes. See **Figure 1-6.**

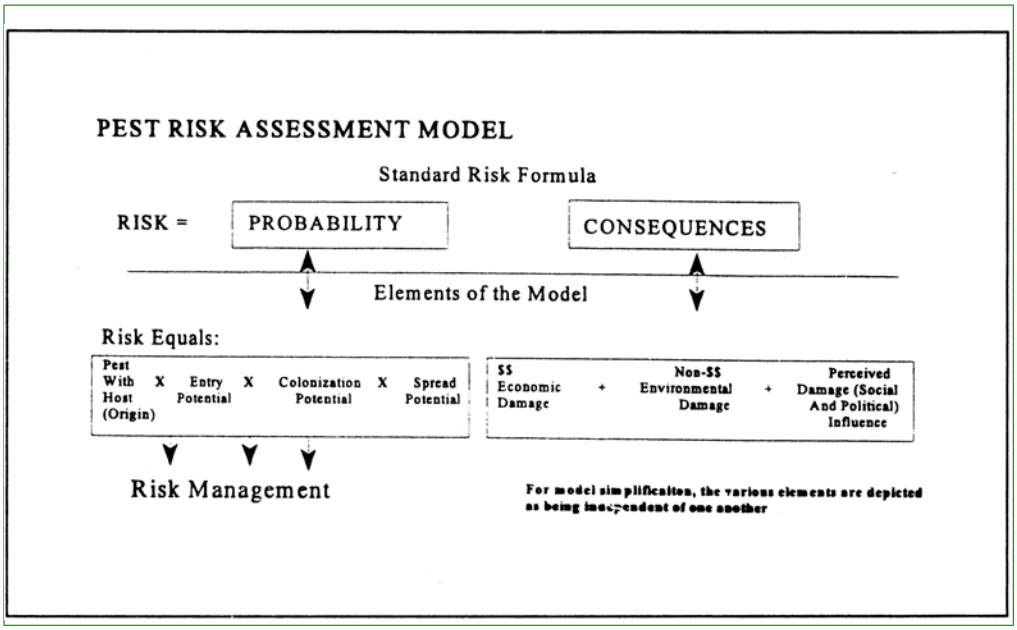

FIGURE 1-6: Pest Risk Assessment Model

The model in Figure 1-6 helps to exemplify that risk equals probability and consequences. It is important to note in this model that AQIM activities are focused in the element of entry potential. The intent of AQIM is to assess entry potential and devise methodologies for reducing or eliminating that potential to the best possible level through the most efficient use of resources. Therefore, PPQ work locations can assess the approach rate of pests, evaluate the rate of detection, and devise methods to minimize or to ameliorate entry of any pest or disease.

It is important that work locations and Risk Management Teams concentrate a majority of their activities on reducing entry potential. However, they must also be aware of the other risk elements that impact overall effectiveness. Final activities at work locations may be influenced by such factors as colonization, spread potential, economic damage potential, environmental damage potential, and socio-political influences.

Referring to Figure 1-6, the probability portion of the standard risk formula is multiplicative. This means that if any of the elements listed are zero (i.e., pest with host origin, entry potential, colonization potential, spread potential), then nothing can happen and there is no risk. However, if there is a positive occurrence or likelihood in all of these elements, then the risk level must be considered.

In Figure 1-6, the second portion of the standard risk formula is consequences. We tend to think of consequences in the negative. How much damage will this pest or disease threat pose in terms of dollars, environment, social, and political elements. The elements of risk consequences (i.e., economic damage potential, environment damage potential, perceived socio-political damage) are additive in nature. You may have a “zero” or non-issue in any two elements. But, as long as one of the elements has a positive impact, then consequences have to be addressed. The intent is to determine if a risk will require mitigation. This brings us to the third part of the pest risk assessment model--risk management.

Risk Management

Risk management is the analysis of various options and the determination of which options can be pursued based upon current operating issues and parameters. The analysis discerns ‘what is viable’. Still, it is the responsibility of the decision-makers to weigh the various options, considering positive implications as well as the negative. All consequences are not equal.

Historically, APHIS has viewed all pest establishments as equally unacceptable. However, some pests may be harder to eradicate than others, and some may be harder to trap or have more long term effects. Management uses risk analysis to give greater specificity in the relative threat levels. Probability of establishment and consequences of impact must mutually be considered.

Therefore, the product of a risk analysis is a conclusion (or characterization) about the relative risk of a particular commodity or pest as it relates to others. It is not an absolute value. It is then up to the decision-makers to judge whether or not the risk is acceptable. If the risk is not acceptable, then the agency must move into risk management: the active intervention to minimize risk elements.

Decision makers must also understand that there is uncertainty in the conclusions. We are conducting predictive analysis. We cannot always be assured that what we think will happen, will in reality, occur. There is no perfect knowledge. In some cases, such as citrus canker and Medfly, the likelihood and impact of establishment is so great, that we can express a high confidence level in the appropriate type of action to take. However, not all situations are so clearly defined.

Risk strategies or decisions usually fall into one of four categories:

- Control of risk,
- Avoidance of risk,
- Risk transfer, or
- Acceptance of risk.

When the probability of the loss occurring is high, the general rule is to either avoid (e.g., commodity exclusion) or control (e.g., fumigation activities) the risk agent. When the probability of the loss is low, generally the activities center around accepting or transferring the risk. Accepting risk is exemplified by the discontinued inspection of low risk pathways. Risk transfer would occur if we decided, on some future date, we would stop excluding a particular commodity that had a high smuggling rate. We would begin to permit entry upon inspection. This way, we have transferred the risk from unknown entry paths to known ones.[1]

Regardless of which avenues are selected, there are certain principles for good risk management decision-making. A good risk management decision:[2]

1 Risk Management. “Designing Risk Management Strategies.” Module 4, Agriculture Canada.
2 Presidential Commission on Risk Assessment and Risk Management. “Framework for Environmental Health Risk Management.” Final Report Volume 1. 1997

- Addressees an articulated problem in its agricultural pest or disease threat context
- Emerges from a decision-making process that elicits the view of those affected by the decision, so that differing technical assessments, public values, knowledge, and perceptions are considered
- Is based on a careful analysis of the weight of scientific evidence that supports conclusions about a problem's potential risks to animal and plant health
- Is made after examining a range of regulatory and non-regulatory risk management options
- Reduces or eliminates risks in ways that:
  - are based on the best available scientific, economic, and other technical information;
  - account for their multi-source, multi-risk contexts;
  - are feasible, with benefits reasonably related to their costs;
  - give priority to preventing risks, not just controlling them;
  - are sensitive to political, social, legal and cultural considerations; and
  - include incentives for innovation, evaluation and research.
- Can be implemented effectively, expeditiously, flexibly, and with stakeholder support
- Can be shown to have a significant impact on the risks of concern
- Can be revised and changed when significant new information becomes available while avoiding "paralysis by analysis."

Multiple elements or factors influence decisions made concerning risk. Management must carefully weigh each option in terms of effectiveness, feasibility, costs, benefits, unintended consequences, and cultural or social impacts.

Risk Communication

Stakeholders play an essential role in this phase by assisting in identifying risk-reduction options, developing and analyzing various avenues to pursue and evaluating the ability of each option to reduce risk (as offset by the above elements such as cost, etc.)
Non-regulatory and regulatory approaches (or some combination) can be used to minimize or eliminate risk. Innovative approaches to

changing behavior relative to risk (i.e., education, market incentives, monitoring, and research) may prove as effective to regulatory restrictions in ensuring compliance.

Risk Management Teams

It is essential to have an infrastructure, such as Risk Management Teams, at work locations to deal with risk analysis and to assist management in making risk-based decisions. Following are general guidelines for the composition and structure of Risk Management Teams.

Composition

The composition of Teams is flexible and should be diverse. Team membership should include Port Directors, managers, officers, and identifiers. Also, membership should include a back-up identifier, persons responsible for AQIM, and a representative of the NAAE.

Structure

The structure of Risk Management Teams depends on the size and complexity of operations at a work location. Team size may vary but should not be greater than 8 members. Larger ports may have more than one team based on the different risk pathways being monitored (i.e., cargo, passenger, etc.).

Skill

Teams need to have various skills. Such a skill base may include having experience of other work locations, using data base systems, and training or experience in researching.

Automated Data Sources for Teams

- Work accomplishment data systems (WADS),
- Pest interceptions (PPQ 309's),
- Importation of regulated articles (PPQ 280's),
- AQIM data
- Pest Not Known To Occur (KNOT's), and
- Recommendations of PPQ's New Pest Advisory Group

Role

The role of Risk Management Teams is to conduct local risk assessments that result in ranking the risks of various pathways associated with plant pests and diseases. Teams:

- Recommend risk management options;

- Identify information needs and methods to obtain information;
- Design sampling processes; and
- Share information with other work locations, industry, States, and regions.

Recommendations from Risk Management Teams may include some of the following options:

- Change selection criteria by validating the existing ones and developing new ones;
- Create release programs for low risk cargo, e.g., border cargo release, maritime or air cargo release;
- Develop compliance agreements for low risk pathways in such areas as aircraft, ships, and rail cars;
- Change the number of units inspected, decreasing or increasing as necessary;
- Allocate staffing based upon relative risk of entry (i.e., pedestrian versus vehicle, cargo versus passenger, solid versus mixed loads, etc.);
- Change cargo inspection protocols (i.e., de-van versus tailgate);
- Target public awareness activities to high risk situations; and,
- Focus on risk (e.g., quality of pest interceptions and quarantine material interceptions, not the quantity)

Risk Management Teams need to:

- Raise AQIM questions, such as, what additional data is needed;
- Explore varying solutions to gathering additional data in a statistical sound format, and
- Share successes and experiences with other Risk Management Teams.

Once Risk Management Teams set issues into context, they need to establish a stakeholder collaboration process to begin risk communication. Stakeholders do not define the risk, but must be involved from the beginning to ensure cooperation and compliance.

Outcome of Risk Analysis

The Risk Management Teams can use risk analysis to answer basic operating questions such as:

- What can go wrong (if we do nothing)?

- What is the probability of an adverse action happening?
- What is or will be the magnitude of the outcome of the adverse action?
- How certain can we be that our predictions are correct?

The outcome of a risk analysis is a risk characterization. A risk characterization should respond to these questions:

- Considering the hazard, what is the nature and likelihood of the pest disease damage to agriculture?
- Which markets or groups are at risk: are some groups more likely to be a risk than others?
- How severe are the anticipated adverse impacts or effects? Are the effects reversible?
- What scientific evidence supports the conclusions about risk? How strong is the evidence? What is uncertain about the nature or magnitude of the risk?
- What is the range of informed views about the nature and probability of the risk? How confident are the analysts about their predictions for risk?
- What other sources cause the same type of effect?
- Does the risk have impacts besides those on agriculture or the environment, such as social or cultural consequences?

The level of detail considered in a risk assessment and included in a risk characterization should be commensurate with the problem's importance (local, regional, national), expected impact, and level of controversy. Risk characterizations must include information that is useful for all stakeholders.

Risk Management Teams:

1. Analyze AQIM survey data to develop estimates of agricultural pest risk approach rates for each major mode of entry at the work location.
2. Use the estimated approach rates to calculate the number of agricultural pests and diseases and high-risk quarantine materials approaching the work location.
3. Compare these numbers with the number of agricultural pests and diseases and high risk quarantine materials actually intercepted at the work location.
4. Use the comparisons from Step 3 above, to draw some conclusions about how well the work location manages the agricultural threat approaching the work location.

5. Report its findings to work location management and PPQ officers. The group recommends actions to take at the work location to improve risk management effectiveness at the work location and recommends risk management targets for the upcoming year. The recommended actions can be based on AQIM analysis or other information collected at the work location. For example, if monitoring data shows a certain commodity to be carrying more agricultural pests than previously suspected or reported, then the work location can inspect that commodity more carefully for interceptions.
6. Then, as the work location continues its baseline monitoring, at the end of the following year (or other time frame) the Teams check to see if the actions initiated in Step 5 above, lead to meeting risk management targets.

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AQIM Handbook

Introduction

AQIM Sampling Process

Information Versus Detection

Sampling for information, also known as objective or random sampling, is used to **estimate characteristics for** a population. On the other hand, sampling for detection, is used to **detect characteristics of** a population. The two types of sampling are fundamentally different in their approach to bias.

Sampling For Information

When sampling to estimate for information, bias in selection must be avoided in order to ensure objectivity in the selection of representative samples from the population. Each member of the population must have a known probability (greater than 0) of being sampled. The result is a high degree of confidence that the sample represents the population, thus useful inference can be made about the population based upon the sample.

The most effective way to eliminate bias is to **randomize** the sampling process and design unbiased selection mechanisms. Mathematical, mechanical, or automated (computerized) systems and random number generators or random number tables are characteristic of the tools commonly used when sampling for information.

Sampling For Detection

Sampling for detection uses bias in order to discover if a specific characteristic occurs in the population. When sampling for detection, the objective is to use prior knowledge to ensure that certain members of the population have a higher probability of being sampled; whenever, prior knowledge indicates that detectable factors or patterns distinguish members of the population.

Using selective criteria based on profiling and similar subjective techniques and drawing from prior knowledge are characteristic of methodologies used when sampling for detection. It is important that such techniques are based on firm information or valid assumptions and applied as consistently as possible in order to detect the largest number of target items.

Summary

Based on the example in Figure 1-7, it would seem that there is a subtle difference between sampling for information and sampling for detection. In fact, it may be argued that sampling for detection, utilizing bias and subjective sampling, will result in better information concerning the amount of prohibited agricultural material carried by vehicles. This may be true, provided the assumptions used for biasing the samples are 100 percent accurate. However, sampling for information would be necessary to determine the soundness of the assumptions. Therefore, the soundness of a scheme sampling for detection cannot be adequately measured without a baseline level of knowledge provided through sampling for information.

Question: What amount of prohibited agricultural material is carried by vehicles?

Sampling for information would require a randomized sample of vehicles over a period of time suitable for the degree of confidence required.

However, if the objective were to detect as much quarantine material as possible, then a sampling **for detection** would be designed based on prior information about the vehicles believed most likely to carry prohibited items.

If no such information is available or the information does not allow for sound assumptions, then a random sample without bias is necessary.

FIGURE 1-7: Example of Sampling for Information Versus for Detection

There are critical, although sometimes subtle, differences between sampling for information and sampling for detection. The use and legitimacy of each is dependent upon the reason sampling is needed (the objective) and the kind of prior information available.

Important

It is important to note that the results of sampling for detection can provide some information about the existence for a characteristic within a population but cannot be used to infer information concerning the entire population. In situations where there is insufficient knowledge from which to develop biases, sampling must be randomized as in sampling for information.

Sampling for information can be more resource intensive than sampling for detection; and it can be difficult to execute in an environment that is focused on detection. Using the same mechanisms (personnel, work areas, etc.) Designed for detection tends to encourage the use of the same biases used for detection. Sampling for information under such conditions requires a special effort to overcome the psychological and logistical tendencies to bias for detection.

Figure 1-8 provides a summary comparison that can be used to quickly determine which type of sampling is most appropriate for a given situation.

Characteristic	Sampling for Information	Sampling for Detection
Type of sampling	Random, objective	Non-random or random; subjective or objective
Randomness	Essential	Not important unless a lack of knowledge prevents sampling from being biased
Bias	Eliminate	Use to advantage

FIGURE 1-8: Summary Comparison To Determine The Most Appropriate Type of Sampling

Random Sampling

A basic introduction to sampling was provided in the subsection titled, Statistics and AQIM beginning on page-1-21. This section will further explain the sampling that is used in AQIM and contrast it to the other types of sampling used by APHIS.

Sampling

First, sampling consists of selecting some part of a larger population to observe so that you can estimate something about the whole population. Sampling is used in a wide variety of situations, some of which you may be very familiar with. Political polls use a random sample of voters to predict who will win an election. A random sample of households with televisions is used to produce the Nielson ratings of television shows. Gallup polls use samples to produce estimates on wide ranging social and political issues. In almost any newspaper, magazine, or broadcast of the evening news you can see information based on some type of sample.

So why do we use samples? Because they provide a practical as well as an economical way to gather needed information. We can't afford (either the time or money) to inspect every person or piece of cargo entering the United States, so a properly chosen random sample can provide an 'estimate' for the sample that is representative of the population. Political polls commonly use around 1,000 voters to predict who is ahead in an election - even in national elections! Remember that with random sampling we can also measure the accuracy of the estimate. Therefore, we use random samples to gather information in a timely and economical manner.

How do we get a representative sample--one which we will be comfortable using to make an inference about the larger population? The answer is, by using the statistical properties of random sampling.

Statistical Criteria For Random Sampling

For a sample to be random, it has to satisfy some statistical criteria:

1. Each unit has an equal chance of being selected. An example from AQIM would be that every air passenger baggage has an equal chance of being in the sample.
2. Each unit is selected independently of other units. An example of this might be that the usual inspection of air passenger baggage from flight X does not influence the selection of the next air passenger baggage to be in the sample.

Random Sampling Contrasted to Other APHIS Sampling Processes

Other sampling being done by APHIS is as follows:

- Haphazard sampling--where an officer points out a number of boxes without any specific knowledge.
- Convenience sampling--officer chooses X number of boxes from the rear of a sea container to do a tailgate inspection.
- Selection criteria (authoritative or intuitive) sampling--based on knowledge and skill of the officer (or sampler).

Each of these types of sampling violate one or both of the statistical criteria for random sampling. Can you determine why these aren't random samples? Would any of the above samples produce a representative sample? Probably not. A selection criteria should have a higher rate of pest and quarantine material interceptions than would a truly random sample, since you are choosing air passenger baggage most likely to have pest and quarantine material interceptions. A convenience sample only looks at the tailgate, so boxes at the front of a container would have no chance of selection. Haphazard sampling may appear to be random, but if the officer knowingly (or unknowingly) excludes any part of the cargo from inspection, then it would not be truly random. An example of haphazard sampling is conducting a blitz of a low risk flight causing misguided random selection to complicate the recovery process.

One of the things that makes random sampling so attractive is that it allows you to attach some measure of confidence or certainty to the data. (Or we can measure some of the error involved with sampling). Why is that important? Remember we took just **one** random sample from our population. If we took another sample, we would end up with different units from the population in the sample. This second sample could give us data that could be very different from the first sample, or it could give us data that is very similar. That's one of the problems of using samples - there are no money-back guarantees. However, we can measure the accuracy of the information we gather. This accuracy

is expressed in the form of a confidence interval. Using random sampling allows us to pick a confidence level, say 95 percent, and express how confident we are that our estimate is within the confidence interval. An example would be that our monitoring data shows that 2 percent of the vehicles crossing at a land border site had interceptions of quarantine material.

Given we used random sampling, we could compute a confidence interval that would allow us to say we were 95 percent certain that the true percentage of vehicles crossing the border at that work location was between 1.4 percent and 2.8 percent.

Telling a work location that their samples HAVE to be random is the easy part. Developing a sampling scheme to suit each work location and pathway is much more difficult. This is why each work location has developed its own sampling process. Some work locations are cooperating with U.S. Customs in sampling. Other locations have set up their own schemes to reflect the unique aspects and abilities of its location and personnel. The important thing is that the samples are random, not that every sample is chosen in a like fashion.

If you have some prior knowledge about the population you are interested in, there can be better (more efficient and cost effective) ways to do the sampling. If the population can be broken up into homogenous groups, then the sample can be drawn from each of the groups. Separate samples are drawn from each strata and inspected. If the stratification was done properly and the samples in each strata are more similar to each other than to the samples in other strata, the resulting confidence interval should be smaller. This doesn't always happen, but if the stratification is done properly, the chances are pretty good you will end up with a better estimate. Refer to **Figure 1-9** for a simplistic example about the importance of knowing your population.

For Example: You have often wondered how many red M & M's are in the 1 lb. bag of candy. Instead of counting all of them, you measure out 4 ounces and count each color and record the results. Your counts reveal:

3 reds, 17 browns, 10 greens, and 14 blues

You then multiply these numbers by four to get your final counts for the entire bag:

12 reds, 68 browns, 40 greens, and 56 blues

Based on your findings, you write a letter to the candy maker to complain; red is your favorite color. Little did you know that the reds are slightly heavier and put in the bag first. Your 4 ounce sample, however, came from the top of the bag and you did not shake it up first. This non-random sample provided inaccurate information about the population.

FIGURE 1-9: Example of Importance of Knowing Your Population

One Final Word on Sampling

As explained above, we could potentially decrease the error in our estimate by using stratified sampling. There is another, more direct, way to control the error (which controls the width of the confidence interval). Increasing the sample size can decrease the error associated with an estimate, regardless of the population size. The error is inversely proportion to the square root of the sample size. So, the larger the sample the narrower the confidence interval around the estimate.

An example of this concept is illustrated in Figure 1-10. If we keep the proportion of pest and quarantine material interceptions constant at 5 percent, watch how changing the sample size changes the width of the confidence interval. If your random sampling unit is only 60 of a population, the confidence interval is between .7 and 20—a very broad interval representing a greater possibility of error. But where the random sampling unit is 600 of the population, the confidence interval is between 3.2 and 7.3—much narrower. So, the larger the sample the narrower the confidence interval will be representing a smaller possibility of error.

Sample Size	Width of the Confidence Level
60	.7 - 20
100	1.1 - 13.5
200	1.8 - 10.4
400	2.6 - 8.5
600	3.2 - 7.3

FIGURE 1-10: Example of How Sample Size Changes the Width of the Confidence Interval

AQIM uses this statistical relationship to determine the different sample sizes for each estimate. To generate the sample size, you need to have some information on the approximate population size and the expected proportion in the population. You also have to choose a confidence level and set the absolute precision at some level. Then, you have to look at the practicality of the situation. Is the sample size realistic in terms of time and money? If not, what sample size would be realistic and would the resulting changes lead to acceptable estimates?

The bottom line is we use random sampling because it allows us to use statistical principles to make assumptions about the resulting sample. It should be an independent, representative part of the population from which we can generate estimates and confidence intervals around the estimate. We can then take the data from AQIM and compare it to other data that is available or combine it with data available from other sources to make more informed decisions.

The random sampling process of AQIM is probably the trickiest part of this effort. Work locations must give considerable thought to a sampling process to ensure the gathering of valid and useful information about pathway risk and program performance. Several sections in this Handbook provide the basic information about sampling methodology to assist work locations produce valid data. The AQIM national team can offer help in setting up a random sampling process that is practical and sustainable at a new work location (see Appendix B for a list of key contacts).

Data Collection and Use

AQIM uses ongoing random sample monitoring to estimate the amount and kind of agricultural materials and pests approaching a work location via various known pest entry **pathways**. A work location may have monitoring estimates on how many pests, contaminants, and smuggled prohibited materials are approaching via air, maritime, or truck cargo. These estimates serve as baseline data to help work locations answer several important questions:

1. How much cargo approaching the work location is carrying actionable pests? What is the level of infestation of the pests in the cargo?
2. Which transportation pathway has the greatest pest risk for the work location?
3. How effective are the current regulations in managing the risk of introduction of pests and diseases?
4. How effective is the work location in managing the pests and quarantine material threats which were identified in the monitoring?
5. How effective is the current cargo hold process for managing the pest threat at the work location?

AQIM data for each entry pathway is collected and entered into AQAS. The work location AQIM data is forwarded to PPQ's QPAS staff, who are currently managing a central database and analyzing national trends. The Center for Plant Health Science and Technology (CPHST) has access to this central database for risk assessments and pathway risk modeling.